General Secondary Education Certificate Examinations in statics

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ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, ٢٠١٢
[Second Stage – First Session]

Mechanics [Mathematics (٢)] **Time : ٢ hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه مهم : ١- يسلم الطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة
٢- الإجابات المكررة عن أسئلة الاختيار من متعدد والصواب والخطأ لن تقدر ويتم تقدير الإجابة الأولى فقط

[الأسئلة في صفحتين]

Remark : Calculators are allowed.

١- Gravitational acceleration g = ٩.٨ m / sec^{٢} الدرجة الفعلية = مجموع الدرجات ÷ ٢

٢- $(\hat{i}, \hat{j}, \hat{k})$ is the set of right hand system of unit vectors, where $\hat{i}$, $\hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane in direction $\overrightarrow{o\,z}$.

I – STATICS

Answer TWO Questions ONLY from the following:

١- (١٠ Marks)

(a) Two forces of magnitudes F , $F + ٤$ newtons act on a particle and the magnitude of their resultant is $4\sqrt{3}$ newtons . If the line action of their resultant is perpendicular to the line action of the smaller force, **find** the value of F and the measure of the angle between the two forces.

(b) ABCD is a rectangle , in which AB = ١٠ cm , BC = ١٢ cm, and X , Y are the mid-points of $\overline{AB}$, $\overline{CD}$ respectively. Forces of magnitudes ١٨ , ٢٠ , ١٨ , ٢٠ , ٢٦ , ٢٦ gm .wt acted along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$, $\overrightarrow{AD}$, $\overrightarrow{AY}$ and $\overrightarrow{CX}$ respectively.

Prove that this system is equivalent to a couple and **find** the norm of its moment.

٢- (١٠ Marks)

(a) The forces $\vec{F}_١ = \hat{i} + ٨\hat{j}$, $\vec{F}_٢ = L\hat{i} + ٥\hat{j}$, $\vec{F}_٣ = \hat{i} - \hat{j}$ act at the point $A\,(٢ , ٣)$. If the sum of moments of these forces about the point $B\,(-١ , ١)$ is $٢٦\hat{K}$, **find** each of: the constant L and the length of the perpendicular segment drawn from the point B to the line action of the resultant of these forces.

(b) $\overline{AB}$ is a light ruler measured in centimeter rests horizontally on two supports at the points C , D such that $C \in \overline{AD}$ and ٢ AC = ٢ BD = CD . A weight of magnitude (W) newton suspended from the point M, lying on the ruler. The ruler is about to rotate if either a weight of ١٠ newtons is suspended at A , or a weight of ٦ newtons is suspended at B. **Find** the magnitude of (W) and **prove** that $\frac{AM}{MB} = \frac{9}{7}$

٣- (١٠ Marks)

(a) AB is a uniform rod of weight ٦ kg.wt (acting at its mid-point). Its end A is fixed at a hinge in a vertical wall . A horizontal force of magnitude F kg.wt acts at its end B such that the rod becomes in equilibrium in a position inclined to the vertical with an angle of measure 60° . **Find** the value of F and the reaction of the hinge at A .

(b) XYZL is a right angled trapezium at X in which $\overline{XL} \,//\, \overline{YZ}$, XY = XL = ١٠ cm and YZ = ٢٠ cm . Forces of magnitudes ٢٠ , $F_١$, $15\sqrt{2}$, ٥ , $F_٢$ newtons act along $\overrightarrow{YX}$, $\overrightarrow{ZY}$, $\overrightarrow{LZ}$, $\overrightarrow{LX}$ and $\overrightarrow{YL}$ respectively . If the line action of the resultant of these forces passes through the point X and is parallel to YL , find the values of $F_١$, $F_٢$

[بقية الأسئلة في الصفحة الثانية]

الدرجة العظمى (٢٠)	جمهورية مصر العربية وزارة التربية والتعليم امتحان شهادة إتمام الدراسة الثانوية العامة لعام ٢٠١٢ م ٤٢ ش.ع نموذج إجابة [الميكانيكا] بالإنجليزية	الدور الأول - المرحلة الثانية
الدرجة الصغرى (—)		عدد الصفحات (٩)

Total mark ٤٠/٢=٢٠	The other solutions should be considered

I : Statics

Question ١ (١٠ marks) | (a) ٥ marks + (b) ٥ marks

(A) ∵ The resultant is perpendicular to the force F

$\therefore F + (F+4)\cos\theta = 0$ **One mark** $\therefore \cos\theta = \frac{-F}{F+4}$ **half** (1)

$\because R^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\theta$ **One mark**

$48 = F^2 + (F+4)^2 + 2\times F\times(F+4)\times\cos\theta$ **half** (2)

from (1), (2)

$\therefore 48 = F^2 + F^2 + 8F + 16 - 2F^2$ **half**

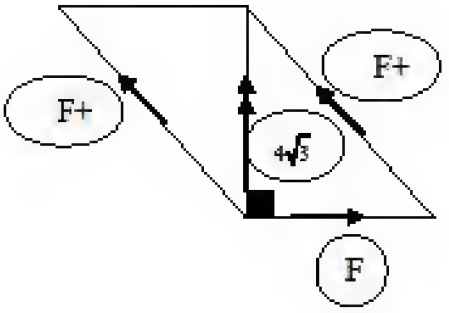
$\therefore 8F = 32 \Rightarrow F = 4$ newton **half** $\therefore \cos\theta = \frac{-4}{8} = \frac{-1}{2}$ **half**

$\Rightarrow m(\angle\theta) = 120^\circ$ **half**

Another solution to find F :

$(F+4)^2 = F^2 + 48$ **One mark** $\therefore F^2 + 8F + 16 = F^2 + 48$ **One mark**

$\therefore 8F = 32 \Rightarrow F = 4$ **half**



(B) $(xC)^2 = (12)^2 + (5)^2 = 169$ $\therefore xC = 13$ $\therefore Ny = \frac{12 \times 5}{13} = xH$ half

(18, 18) form couple whose moment is =

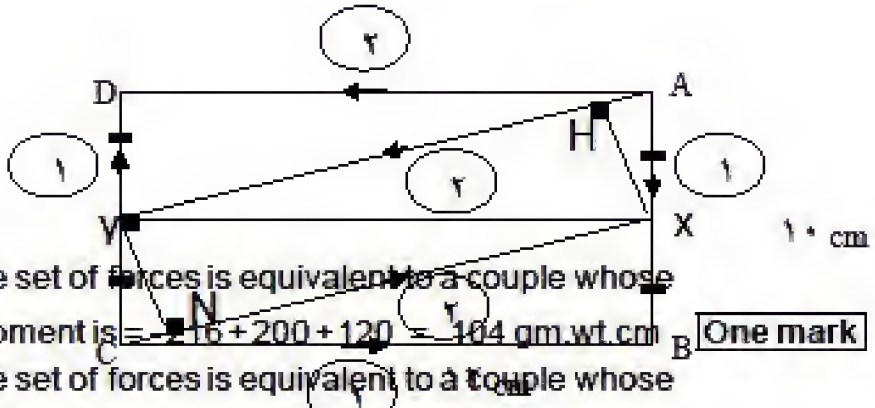
$-18 \times 12 = -216$ gm.wt.cm One mark

(20, 20) form couple whose moment is =

$20 \times 10 = 200$ gm.wt.cm One mark

(26, 26) form couple whose moment is =

$26 \times \frac{12 \times 5}{13} = 120$ gm.wt.cm One mark



∴ The set of forces is equivalent to a couple whose moment is $= -216 + 200 + 120 = -104$ gm.wt.cm One mark

∴ The set of forces is equivalent to a couple whose moment's norm is 104 gm.wt.cm half

(تراعى الحلول الأخرى)

Question ٢ (١٠ marks) | (a) ٦ marks + (b) ٤ marks

(A)

$\vec{R} = (2+L)\hat{i} + 12\,\hat{j}$ **two marks**

$\because \vec{M}_B = \vec{BA} \times \vec{R}$ **One mark**

$\therefore 26\,\hat{k} = (3\,\hat{i} + 2\,\hat{j})$ **half** $\times [(2+L)\hat{i} + 12\,\hat{j}]$ **half**

$\therefore 26\,\hat{k} = (32 - 2L)\hat{k}$ **half**

$\therefore L = 3$ **half** & $\vec{R} = 5\,\hat{i} + 12\,\hat{j}$

$\therefore$ The length of the line segment drawn from the point B to the line action of the resultant $\vec{R} = \frac{\|\vec{M}_B\|}{\|\vec{R}\|}$ **half** $= \frac{26}{13} = 2$ length unit **half**

(B) Let : $2AC = 2BD = CD = 2L$ cm **half**

(First) $\because M_C = 0$ **half** $\therefore W\,x = 10L$ ..... (1) **half**

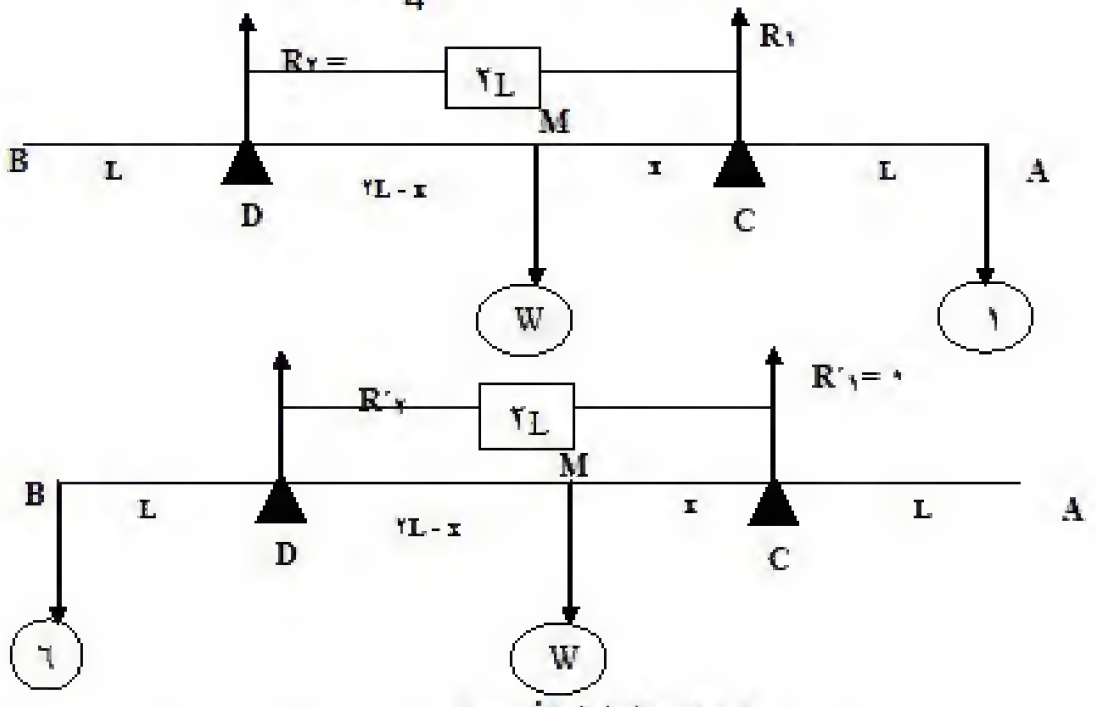
(Second) $\because M_D = 0$ **half** $\therefore 6L = W(2L - x)$

$\therefore W\,x = 2L(W - 3)$ ..... (2) } **half**

from (1) and (2) we get $2(W-3) = 10 \Rightarrow W = 8$ newtons **half**

and from (1) $8x = 10L \Rightarrow x = \frac{5}{4}L$ **half**

$\therefore \frac{AM}{MB} = \frac{L+x}{3L-x} = \frac{L+\frac{5}{4}L}{3L-\frac{5}{4}L} = \frac{9}{7}$ **half**



(تراعى الحلول الأخرى)

Question ٣ (١٠ marks) | (a) ٥ marks + (b) ٥ marks

(A) Assume that the line actions of the weight and the horizontal force F intersect in D

$\therefore$ The reaction "R" at the hinge must pass through the point D.

Let $AB = 4L \Rightarrow AC = 2L, BC = 2\sqrt{3}\,L$

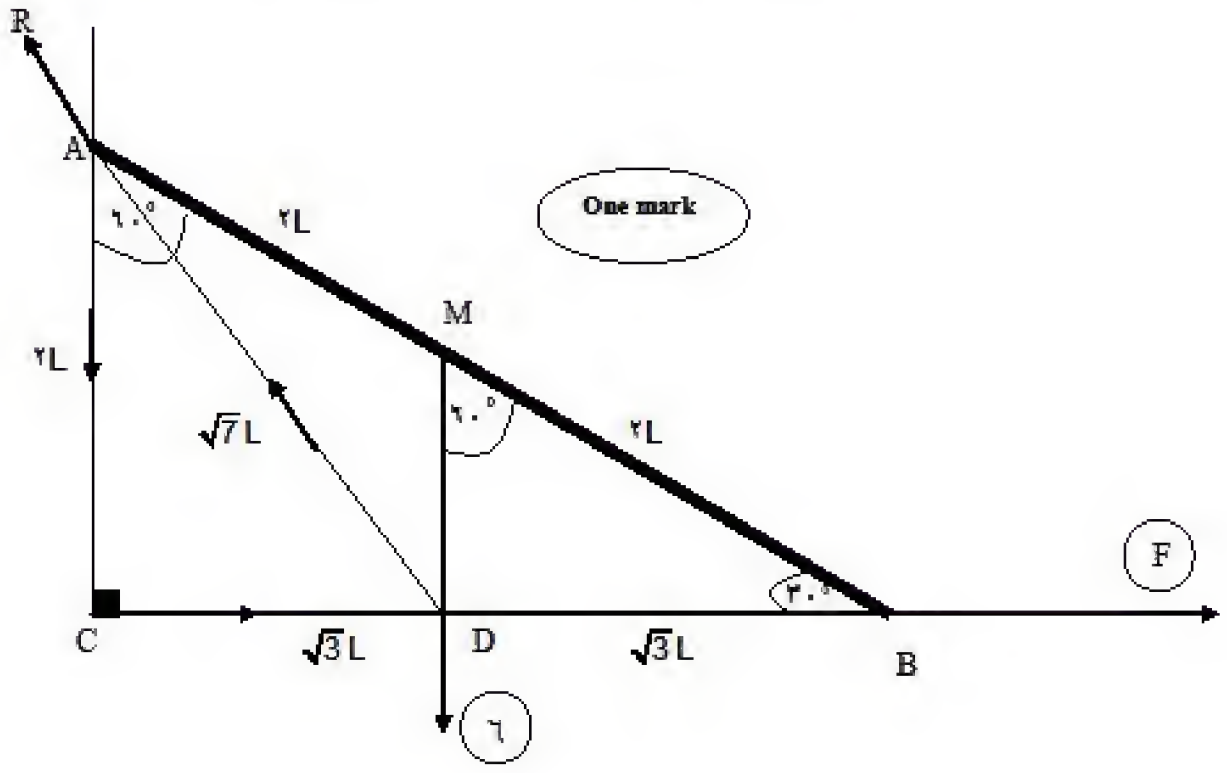
$\therefore (AD)^2 = (\sqrt{3}\,L)^2 + (2L)^2 = 7L^2$

$\therefore AD = \sqrt{7}\,L$ **half**

CDA is the triangle forces **half** $\Rightarrow \frac{F}{CD} = \frac{R}{DA} = \frac{6}{AC}$ **One mark**

$\therefore \frac{F}{\sqrt{3}\,L} = \frac{R}{\sqrt{7}\,L} = \frac{6}{2L}$ **One mark**

$\therefore F = 3\sqrt{3}$ kg.wt **half** & $R = 3\sqrt{7}$ kg.wt **half**



(تراعى الحلول الأخرى)

(B) From the properties of the geometerical shape

$LY = 10\sqrt{2}$ cm, $XH = XN = 5\sqrt{2}$ cm, $LM = 10$ cm **half**

$\because$ The line action of the resultant // $\overleftrightarrow{YL}$

$\therefore M_Y = M_L$ **One mark**

$\therefore -5\times10 + 15\sqrt{2}\times10\sqrt{2}$ **half** $= F_1\times10 + 20\times10$ **half**

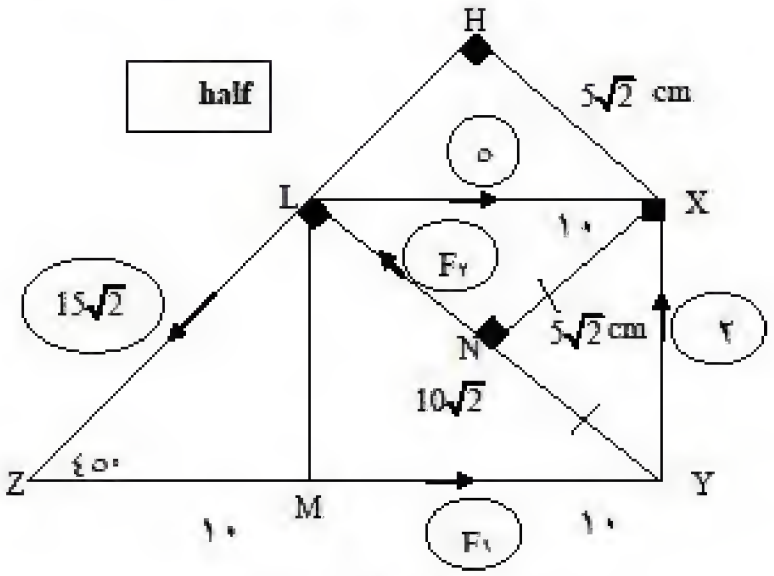
$\therefore -5 + 30 = F_1 + 20 \Rightarrow F_1 = 5$ newtons **half**

$\because$ The line action of the resultant passes through the point X

$\therefore M_X = 0$ **half**

$\therefore -F_2\times5\sqrt{2} + 5\times10 + 15\sqrt{2}\times5\sqrt{2}$ **half** $= 0$

$\therefore \sqrt{2}F_2 = 40 \Rightarrow F_2 = 20\sqrt{2}$ newtons **half**



(تراعى الحلول الأخرى)

ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, 2011
[Second Stage – First Session]

[٧٧] ث.ع / أول / ج

Mechanics [Mathematics (2)] **Time: 2 Hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه هام : يسلم الطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة [الأسئلة فى صفحتين]

Remark : Calculators are allowed.

(1) Gravitational acceleration $g = 9.8 \text{ m / sec}^2$

(2) $(\hat{i}, \hat{j}, \hat{k})$ is the set of right – hand system of unit vectors, where $\hat{i}$, $\hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane .

I - STATICS

Answer TWO Questions ONLY from the following

1 - (a) Two forces of magnitudes 4 , F kg.wt acts on a particle and the measure of the angle between them is $120°$. If the line action of their resultant is perpendicular to the line action of the first force. **Find** the value of F , then **find** the magnitude of the resultant of the two forces .

(b) The force $\vec{F} = L\hat{i} + M\hat{j}$, acts at the point $A = (2, -1)$ and the algebraic measure of its moment about the point $B = (1, 4)$ equals 11 moment unit , and its moment about the point $D = (-1, 3)$ vanishes. **Find** the magnitude of $\vec{F}$.

2 - (a) AB is a rod of length 100 cm and of weight 20 Newton acts at its midpoint, rests in a horizontal position on two supports, one of them is at a distance 30 cm from A , and the other is at a distance 20 cm from B. **Find** the magnitude of the pressure on each of the two supports. **Find** the magnitude of the weight that should be suspended at B such that the rod is about to rotate. Then **Find** the value of the pressure on the support which is nearest to the point B at this instant.

(b) ABCD is a rectangle , in which AB = 9 cm , BC = 24 cm . H , F are the mid points of $\overline{BC}$, $\overline{AD}$ respectively . Forces of magnitudes 18 , 48 , 30 , 24 gm.wt act along $\overrightarrow{AB}$, $\overrightarrow{BC}$, $\overrightarrow{CF}$ and $\overrightarrow{FA}$ respectively. **Prove that** this system is equivalent to a couple , and **find** its moment norm. Then **find** the magnitude of the two forces which act along $\overrightarrow{HA}$, $\overrightarrow{FC}$ such that the two forces will be in equilibrium with the given forces.

3 - (a) A smooth sphere of weight 30 Newton rests on a smooth vertical wall and is suspended from a point on its surface by a light string, the other end of the string is attached to a point on the wall vertically above the point of contact between the wall and the sphere If the length of the string equals the radius of the sphere . **Find** the tension in the string and the reaction of the wall in state of equilibrium.

(b) ABC is an isosceles triangle in which $m(\angle A) = 120°$, forces of magnitudes 4 , 4 and $4\sqrt{3}$ kg.wt are acting along $\overrightarrow{AB}$, $\overrightarrow{AC}$ and $\overrightarrow{BC}$ respectively . **Prove that** the line action of the resultant of these forces passes through the midpoint of $\overline{BC}$ and parallel to $\overleftrightarrow{AC}$

[بقية الأسئلة فى الصفحة الثانية]

جمهورية مصر العربية
وزارة التربية والتعليم
امتحان شهادة إتمام الدراسة الثانوية العامة لعام ٢٠١١ م
نموذج إجابة امتحان مادة [الميكانيكا (٢) بالإنجليزية]

المرحلة الثانية

الدور الأول

الدرجة الكلية : (٤٠) درجة ثم تقسم على (٢) لتصبح الدرجة الفعلية (٢٠) درجة

أولاً : الإستاتيكا

إجابة السؤال الأول (عشر درجات)	الفقرة (a) خمس درجات ، الفقرة (b) خمس درجات

(a)

∵ The resultant $\perp$ to the first force $\therefore \bar{F}_1 + \bar{F}_2 \cos\alpha = 0$ ١

$٤ + F\left(\frac{-1}{2}\right) = ٠$ ٠,٥

$F = ٨$ kg.wt ٠,٥

$R^٢ = F_١^٢ + F_٢^٢ + ٢ F_١ F_٢ \cos\alpha$ ١

$\therefore R^٢ = ١٦ + ٦٤ - ٢ \times ٤ \times ٨ \times \frac{1}{2}$ ١ $= ٤٨$ ٠,٥

$\therefore R = 4\sqrt{3}$ kg.wt ٠,٥

(b)

$\vec{M}_B = \vec{BA} \times F$ ٠,٥ $\quad 11\hat{k} = (\hat{i} - 5\hat{j}) \times (L\hat{i} + M\hat{J})$ ٠,٥

$11\hat{k} = (M + 5L)\hat{k}$ ٠,٥ $\quad \therefore M + ٥L = ١١$ ..... (١) ٠,٥

$\vec{M}_D = \vec{DA} \times \vec{F}$ ٠,٥ $\quad 0 = (3\hat{i} - 4\hat{j}) \times (L\hat{i} + M\hat{J})$ ٠,٥

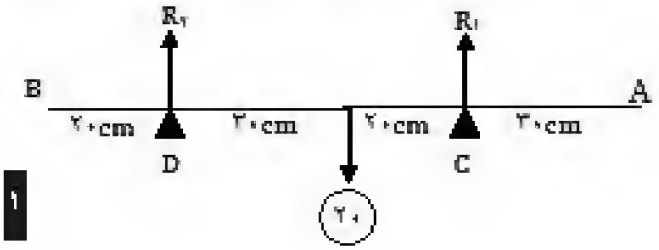
$0 = (3M + 4L)\hat{k}$ ٠,٥ $\quad \therefore ٣M + ٤L = ٠$ ..... (٢) ٠,٥

From (١) , (٢) $\quad L = ٣ \ , \ M = -٤ \quad \therefore \bar{F} = (3\hat{i} - 4\hat{j})$ ٠,٥

$\|F\| = \sqrt{9+16} = ٥$ force unit ٠,٥

إجابة السؤال الثانى (عشر درجات)	الفقرة (a) خمس درجات ، الفقرة (b) خمس درجات

(a) **The first case** :



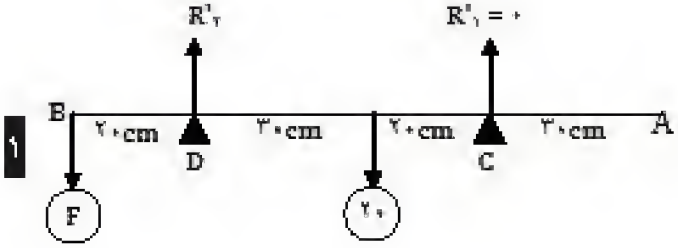
$R_1 + R_2 = ٢٠$ ..... (١) ١

$M_D = ٠ \quad \therefore R_2 \times ٥٠ - ٢٠ \times ٣٠ = ٠$ ١

$\therefore R_2 = ١٢$ Newton ٠,٥

From (١) : $R_1 = ٨$ Newton ٠,٥

The second case :



$M_D = ٠ \quad \therefore F \times ٢٠ - ٢٠ \times ٣٠ = ٠$ ١

$F = ٣٠$ Newton ٠,٥

$R'_2 = ٢٠ + ٣٠ = ٥٠$ Newton ٠,٥

(b) $\frac{18}{9} = \frac{48}{24} = \frac{30}{15} = \frac{24}{12} = 2$ ١

$\therefore$ Forces are proportional with sides length and act in same cyclic order

$\therefore$ The system equivalent to a couple its moment :

$M = -2 \times 2 \times \frac{12+24}{2} \times 9$ ١ $= -١٤٨$ Newton . cm ٠,٥

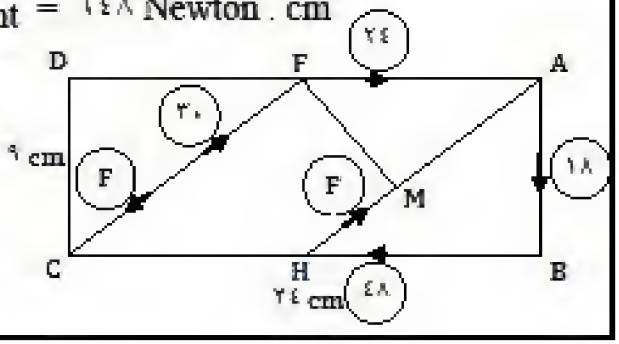
The system equivalent to a couple its moment $= -١٤٨$ Newton . cm ٠,٥

(F , F) are two forces form a couple its moment $= ١٤٨$ Newton . cm

$F \times 12 \sin DAM = ١٤٨$ ١

$F \times 12 \times \frac{9}{15} = ١٤٨$ ٠,٥

$\therefore F = ٩٠$ Newton ٠,٥

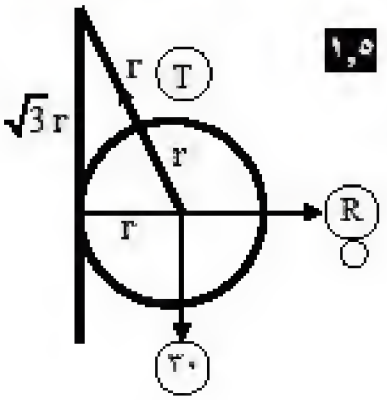


The two forces ٩٠ , ٩ Newton

تراعى الحلول الأخرى

إجابة السؤال الثالث (عشر درجات) | الفقرة (a) خمس درجات ، الفقرة (b) خمس درجات

(a) ١,٥



By using the triangle force rule :

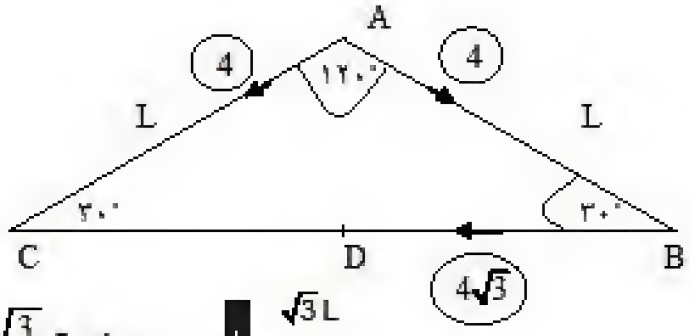
٠,٥ ٠,٥ ٠,٥

$$\therefore \frac{T}{2r} = \frac{R}{r} = \frac{30}{\sqrt{3}\,r}$$

$\therefore T = 20\sqrt{3}$ Newton ١

$\therefore F = 10\sqrt{3}$ *Newton* ١

(b)



Let AB = AC = L cm

$\therefore$ BC = $\sqrt{3}$ L cm , D mid of $\overline{BC}$

$M_D = -4 \times \frac{\sqrt{3}}{2} L \sin ٣٠$ ١ $+ 4 \times \frac{\sqrt{3}}{2} L \sin ٣٠$ ١

$= 0$ ٠,٥

Line action of resultant passing through mid of $\overline{BC}$

$M_A = -4\sqrt{3}\, L \sin ٣٠ = -2\sqrt{3}\, L$ kg .wt. . cm. ١

$M_C = -4\, L \sin ٦٠ = -2\sqrt{3}\, L$ kg .wt. . cm. ١

ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, ٢٠١٢
[Second Stage – Second Session]

Mechanics [Mathematics (٢)] **Time : ٢ hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه مهم : ١- يسلم الطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة
٢- الإجابات المكررة عن أسئلة الاختيار من متعدد والصواب والخطأ لن تقدر ويتم تقدير الإجابة الأولى فقط

[الأسئلة فى صفحتين]

Remark : Calculators are allowed.

١- Gravitational acceleration g = ٩.٨ m / sec^{٢} الدرجة الفعلية = مجموع الدرجات ÷ ٢

٢- $(\hat{i}, \hat{j}, \hat{k})$ is the set of right hand system of unit vectors, where $\hat{i}$, $\hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane in direction $\overrightarrow{o\,z}$.

I – STATICS

Answer TWO Questions ONLY from the following:

١- (١٠ Marks)

(a) Two forces of magnitudes F , $F\sqrt{2}$ Newton act on a particle and include between them an angle of measure 135° . Find the measure of the inclination angle of the resultant to the greater force , then find the value of F when the magnitude of their resultant equals $3\sqrt{2}$ Newton.

(b) ABCD is a square of side length ١٠ cm. x , y are the mid points of $\overline{AD}$, $\overline{DC}$ respectively . Forces of magnitudes F , K , ١٨ gm . wt act along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$ respectively . If the line action of their resultant is $\overleftrightarrow{xy}$, find the values of F , K .

٢- (١٠ Marks)

(a) A body of weight ٢٤ gm. wt is placed on a smooth plane inclined to the horizontal at an angle θ° where $\tan\theta = \frac{3}{4}$. The body is kept in equilibrium under the action of a horizontal force of magnitude F gm.wt . Find the value of F and the reaction of the plane to the body.

(b) $\overline{AB}$ is a non-uniform rod of length (one meter) and weight ٢٥ kg. wt . It rests in a horizontal position on two supports at C , D where AC = BD = ١٠ cm . If a weight of magnitude ٥٠ kg . wt is hanged at its end A, then the rod is about to rotate around C . Find the point of action of the rod weight , then find the maximum weight that can be suspended at B , without disturbing the equilibrium and without removing the weight at A .

٣- (١٠ Marks)

(a) The force $\vec{F} = L\hat{i} + M\hat{j}$ acts at the origin point O. If the algebraic measure of its moments about the two points A = (٣ , ٠) , B = (٠ , ٣) equal ٩ , ١٢ moment unit, respectively, find the value of L,M and then find the length of the perpendicular segment drawn from the point B to the line action of this force.

(b) ABCD is a rectangle in which AB = ٤ cm , BC = ٧ cm . The point E $\in \overline{BC}$ such that CE = ٣ cm . Forces of magnitudes ٦ , ١٤ , ٦ , ١٠ and $٨\sqrt{2}$ gm.wt acted along $\overrightarrow{AB}$, $\overrightarrow{AD}$, $\overrightarrow{CD}$, $\overrightarrow{DE}$ and $\overrightarrow{EA}$ respectively . Prove that the system is equivalent to a couple and find the norm of its moment.

[بقية الأسئلة فى الصفحة الثانية]

ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, 2011
[Second Stage – Second Session]

[٧٧] ث.ع / تلن / ج

Mechanics [Mathematics (2)] **Time: 2 Hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه مهم : يسلم الطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة [الأسئلة في صفحتين]

Remark : Calculators are allowed.

(1) Gravitational acceleration $g = 9.8 \text{ m / sec}^2$

(2) $(\hat{i} , \hat{j} , \hat{k})$ is the set of right – hand system of unit vectors, where $\hat{i} , \hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane .

I - STATICS

Answer ONLY TWO Questions from the following

1 - (a) Two forces of magnitudes $4 , 2\sqrt{3}$ kg.wt acts on a particle and the measure of the angle between them is 150° **find** the magnitude of their resultant and the measure of the angle which makes with the greatest forces .

(b) The force $\vec{F} = 6\hat{i} - 8\hat{j}$, acts at the point $A = (1 , 2)$. **Find** the moment vector of this force about the point $B = (-3 , -1)$, then **find** the length of the perpendicular segment drawn from the point B to the line action of the force.

2 - (a) AB is a uniform rod of length 120 cm and of weight 15 Newton acts at its midpoint, rests in a horizontal position on two supports, one of them is at the end A and the other at a point 20 cm distance from B, **find** the magnitude of the weight that should be suspended at B such that the magnitude of the reaction on the nearest support to this end equals three time the magnitude of the reaction on the support A , hence **find** the magnitudes of these reactions at this instant .

(b) ABCD is a square of side length 20 cm , Forces of magnitudes 6 , 7 , 6 , 7 Newtons acting along $\overrightarrow{AB}$, $\overrightarrow{CB}$, $\overrightarrow{CD}$ and $\overrightarrow{AD}$ respectively , and two forces each of magnitude $4\sqrt{2}$ Newtons acting at the points A , C in the direction of $\overrightarrow{BD}$, $\overrightarrow{DB}$ respectively . **Find**:

1) Norm of the moment of the couple that equivalent to this system of forces.

2) The magnitude and direction of two forces acting at B, D which are both parallel to $\overleftrightarrow{AC}$ and make the system in equilibrium .

3 - (a) A weight of magnitude 200 gm wt is suspended by two strings of lengths 60 cm , 80 cm from two points on the same horizontal line, the distance between them 100 cm . **Find** the tension in each string.

(b) ABCD is a rectangle in which AB = 8 cm , BC = 6 cm , H is the mid-point of !AB , forces of magnitudes 2 , 3 , 4 , 5 , $5\sqrt{13}$ Newton acting along $\overrightarrow{BC}$, $\overrightarrow{DC}$, $\overrightarrow{DA}$, $\overrightarrow{BD}$ and $\overrightarrow{HC}$ respectively . **Find** the algebraic sum of the moments of these forces about each of the points B , C.

[بقية الأسئلة فى الصفحة الثانية]

ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, 2010
[Second Stage – First Session]

٢٩ ث.ع / أول

Mechanics [Mathematics (2)] **Time : 2 hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه هام : يسلم للطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة (الأسئلة فى صفحتين)

Remark : Calculators are allowed.

(1) Gravitational acceleration $g = 9.8 \text{ m / sec}^2$

(2) $(\hat{i}, \hat{j}, \hat{k})$ is the set of right – hand system of unit vectors, where $\hat{i}$, $\hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane .

I – STATICS

Answer TWO Questions ONLY from the following

1 - (a) Two forces of magnitudes $6\sqrt{3}$, 6 Newton act on a particle and the measure of the angle between them is 150^0 . Find the magnitude of their resultant and the measure of the angle which it makes with the greater force.

(b) The two forces $\vec{F}_1 = 5\hat{i} - \hat{j}$, $\vec{F}_2 = \hat{i} + 9\hat{j}$ act at the point $A = (1, 3)$
Find the moment vector of their resultant with respect to the point $B = (5, 0)$, then **calculate** the length of the perpendicular drawn from the point B to the line of action of the resultant.

2- (a) ABCD is a parallelogram , in which AB = 18 cm , BC = 20 cm , $m(\hat{A}) = 3\phi$
Forces of magnitudes 8 , 6 , 8 , 6 Newtons act along $\overrightarrow{BA}$, $\overrightarrow{BC}$, $\overrightarrow{DC}$ and $\overrightarrow{DA}$ respectively. Prove that this system is equivalent to a couple then find the norm of its moment, then find the magnitude of each of the two forces which act at A , D and are perpendicular to $\overline{AD}$ and equivalent to the previous system .

(b) A uniform wooden beam AB (its weight acts at its midpoint) of length 16 m , and its a weight is 40 kg.wt. , rests in a horizontal position on two supports, one of them is at distance of 2 meter from A , and the other is at a distance of 4 meter from B. If a man whose weight is 80 kg.wt ascended on the beam , **find** the magnitude of the reaction of each of the two supports on the beam when the man stands at A . If the man move on the beam starting from A towards B, **find** the maximum distance which the man can moves such that the beam does not overturn.

3- (a) A body of weight 12 Newtons is suspended from one end of a light string whose length 130 cm . The other end is fixed at a point in the vertical wall, the body is pulled by a horizontal force which makes it at equilibrium when it is at distance $50\ cm$ from the wall. **Find** the magnitude of each of the force and the tension in the string .

(b) Two forces $\vec{F}_1$, $\vec{F}_2$ act at the two points A , B respectively in perpendicular direction on $\overleftrightarrow{AB}$ where AB = 30 cm , and their resultant $\vec{R} = -3\hat{i} + 4\hat{j}$ act at the point $C \in \overleftrightarrow{AB}$ given that $\vec{F}_2 = -6\hat{i} + 8\hat{j}$ **determine** $\vec{F}_1$ and the length of $\overline{BC}$

[بقية الأسئلة فى الصفحة الثانية]

ARAB REPUBLIC OF EGYPT
Ministry of Education
General Secondary Education Certificate Examination, 2010
[Second Stage – Second Session]

Mechanics [Mathematics (2)] **Time : 2 hours**

الميكانيكا [رياضيات (٢)] باللغة الإنجليزية

تنبيه هام : يسلم للطالب ورقة امتحانية باللغة العربية مع الورقة المترجمة (**الأسئلة فى صفحتين**)

Remark : Calculators are allowed.

(1) Gravitational acceleration $g = 9.8 \text{ m / sec}^2$

(2) $(\hat{i}, \hat{j}, \hat{k})$ is the set of right – hand system of unit vectors, where $\hat{i}$, $\hat{j}$ are orthogonal in the direction of $\overrightarrow{o\,x}$ and $\overrightarrow{o\,y}$ respectively, while $\hat{k}$ is perpendicular to their plane .

I – STATICS

Answer TWO Questions ONLY from the following

1 - (a) The coplanar forces of magnitudes $2, 4, 2\sqrt{3}$ Newton act on a particle along the directions east , 60^0 north of the east , 30^0 south of the west respectively . **Find** the magnitude of the resultant of these forces and the measure of the angle between the resultant and the first force .

(b) A B is a uniform rod of length 180 cm and weight of magnitude 120 Newton (acting at its middle). The rod is suspended horizontally by two vertical light strings at its ends . **Find** the position of suspending (on the rod) a weight of magnitude 300 Newton so that the magnitude of the tension at the end A is double the magnitude of the tension at the end B .

2- (a) The force $\bar{F} = 3\hat{i} - 3\hat{j}$ act at the point $A = (0, 3)$, **Find** The moment vector of $\bar{F}$ with respect to the two points $B = (4, 3)$, $E=(-2,1)$. Hence **prove that** the line of action of $\bar{F}$ bisects $\overline{BE}$.

(b) ABC is a right angled triangle at B , in which AB = 3 cm , BC = 4 cm. Forces of magnitudes 12 , 16 , 20 Newton act along $\overline{AB}$, $\overline{BC}$, $\overline{CA}$ respectively . **Prove that** the system of these forces is equivalent to a couple then find the norm of its moment . Also **find** the magnitudes of the two forces which act at A , C and are perpendicular to $\overline{AC}$ which make the system to be in equilibriun .

3- (a) A body whose weight is of magnitude 9 Newton is placed on a smooth plane which inclines to the horizontal at angle of measure 30° . The body is kept in equilibrium by a force of magnitude F Newton which inclines to the line of the greatest slope of the plane at angle of measure 30^0 upwards . **Find** the value of F , then find the magnitude of the reaction of the plane on the body.

(b) ABCD is a trapezium in which $m(\angle ABC) = m(\angle BDC) = 90^\circ$, $\overline{AD} // \overline{BC}$, AB = 12 cm , BC = 25 cm and AD = 9 cm . Forces of magnitudes 75 , F , 50 Newton act along $\overline{DA}$, $\overline{BA}$, $\overline{DB}$ respectively . If the algebraic sum of the measure of moments of these forces about C vanishes, **find** F . Then **find** the algebraic sum of the measure of moments of these forces about E where $E \in \overline{BC}$, BE = 5 cm

[بقية الأسئلة فى الصفحة الثانية]